

CALIBRATION STANDARD SPECIFICATION
FOR A
RUGGEDIZED PANEL METER CALIBRATOR
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PROCUREMENT PACKAGE

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CALIBRATION STANDARD SPECIFICATION FOR
A RUGGEDIZED PANEL METER CALIBRATOR

1. SCOPE

1.1 Scope. This specification defines the mechanical, electrical, and electronic characteristics for a Ruggedized Panel Meter Calibrator to be used in the Navy Metrology and Calibration Program. This equipment is intended for use by Navy personnel in shipboard and shoreboard laboratories to calibrate shipboard panel meters in the laboratory and in place at the meter panels. Panel meters such as AC and DC voltage and current meters, AC power, power factor and phase meters and synchroscope shall be calibrated by the calibrator. For the purposes of this specification, the Ruggedized Panel Meter Calibrator shall be referred to as the RPMC.

2. Controlling Specifications. MIL-T-28800, "Military Specification, Test Equipment for Use with Electrical and Electronic Equipment, General Specification for", and all documents referenced therein of the issues in effect on the date of the solicitation shall form a part of this specification.

3. REQUIREMENTS

3.1 General. The RPMC shall conform to Type II, Class 5, Style E requirements as specified in MIL-T-28800 for Navy shipboard and shorebased use as modified below. The use of material restricted for Navy use shall be governed by MIL-T-28800.

3.1.1 Design and Construction. The RPMC design and construction shall meet the requirements of MIL-T-28800 for Type II or III equipment.

3.1.2 Power Requirements. The RPMC shall operate from a source of 103.5V to 126.5V at 50 Hz and 60 Hz $\pm 5\%$ single phase input power as specified in MIL-T-28800.

3.1.2.1 Fuses or Circuit Breakers. Fuses or circuit breakers shall be provided. If circuit breakers are used, both sides of the power source shall be automatically disconnected from the equipment in the event of excessive current. If fuses are used, only the line side of the input power line as defined by MIL-C-28777 shall be fused. Fuses or circuit breakers shall be readily accessible.

3.1.2.2 Power Connections. The requirements for power source connections shall be in accordance with MIL-T-28800 with a 6 foot minimum length cord.

3.1.3 Dimensions and Weight . Maximum dimensions shall not exceed 17 inches in width, 12 inches in height, 15 inches in depth. The weight including all covers, one set of 10 feet cables and the Hand Held Unit (HHU) shall not exceed 40 pounds.

3.1.4 Lithium Batteries. Per MIL-T-28800, lithium batteries are prohibited without prior authorization. A request for approval for the use of lithium batteries, including those encapsulated in integrated circuits, shall be submitted to the procuring activity at the time of submission of proposals. Approval shall apply only to the specific model proposed.

3.2 Environmental Requirements. The RPMC shall meet the environmental requirements for Type II, Class 5, Style E equipment with the deviations specified below:

	<u>Temperature (°C)</u>	<u>Relative Humidity (%)</u>
Operating	10 to 30	95
	30 to 40	75
Non-operating	-40 to 70	Not Controlled

3.2.2 Electromagnetic Compatibility. The electromagnetic compatibility requirements of MIL-T-28800 are limited to the following areas: CE01, CE03, CS01, CS02, CS06, RE01, RE02 (14 kHz to 1 GHz), and RS03.

3.3 Reliability. Type II or III reliability requirements are as specified in MIL-T-28800.

3.3.1 Calibration Interval. The RPMC shall have the a 85% or greater probability of remaining within tolerances on all specifications at the end of a 12 month period.

3.4 Maintainability. The RPMC shall meet the Type II maintainability requirements as specified in MIL-T-28800 except the lowest discrete component shall be defined as a replaceable assembly. Certification time shall not exceed 60 minutes.

3.5 Performance Requirements. The RPMC shall provide the performance capabilities as listed below. Unless otherwise indicated, all performance specifications shall be met following a 20 minute warm-up period. Note: All uncertainties are expressed as a percentage of the indicated value (i.v.) plus a percentage of the range in use (rng).

3.5.1 DC Voltage Mode.

3.5.1.1 Range. The RPMC shall provide a minimum DC voltage range from 10 mV to 1000 V. The DC voltage shall be bipolar and adjustable over the full range. Ranges shall be approximately decade steps.

3.5.1.2 Amplitude Uncertainty. The RPMC amplitude uncertainty shall not exceed $\pm(0.2\%$ of reading + 0.05% rng). This uncertainty specification shall apply over the full range of load and line voltage variations.

3.5.1.3 Resolution and setability. The RPMC shall have the resolution of DC voltage amplitude to at least 0.1 percent of the output voltage or better. The DC voltage shall be settable to at least 0.1 percent of the output voltage.

3.5.1.4 Burden. The RPMC shall support a current burden of up to 15 mA limited to 10 volt amps (VA).

3.5.1.5 Remote Sensing. Two wire remote sensing shall be provided for the DC voltage output via the RPMC voltage output connector

3.5.1.6 Level Stability Output voltage variations of less than 10 Hz shall be less than or equal to $\pm(0.03\%$ i.v. +0.015% rng) peak over a 15 minute period.

3.5.2 AC Voltage Mode.

3.5.2.1 Amplitude Range. The RPMC shall have a minimum AC voltage range from 1.5 Vrms to 750 Vrms. The AC voltage shall be adjustable over the full output range. The AC voltage ranges shall be approximately 15 Vrms, 150 Vrms, and 750 Vrms.

3.5.2.1.1 Amplitude Uncertainty. The RPMC AC amplitude uncertainty shall not exceed $\pm(0.2\%$ of reading + 0.05% rng) on the 15 and 150 V range and $\pm(0.2\%$ of reading + 0.10% rng) on the 750 V range. This uncertainty specification shall apply over the full range of load and line voltage variations.

3.5.2.1.2 Resolution and Setability. The RPMC shall have the resolution of AC voltage amplitude to at least 0.1 percent of the output voltage or better. The AC voltage shall be settable to at least 0.1 percent of the output voltage.

3.5.2.1.3 Burden. The RPMC shall support an AC current burden of:

170 mA rms for voltages < 150 Vrms
10 VA for voltages > 150 Vrms

3.5.2.1.4 Remote Sensing. Two wire remote sensing shall be provided for the AC voltage output via the RPMC voltage output connector.

3.5.2.1.5 Level Stability. Output voltage variations of less than 10 Hz shall be less than or equal to $\pm(0.03\% \text{ i.v.} + 0.015\% \text{ rng})$ peak over a 15 minute period.

3.5.2.2 Frequency Range. The AC voltage range shall have the frequency selection of 60 Hz or 400 Hz operation, and a means of varying and setting the frequency above and below these nominal values, over the following ranges: 50 to 70 Hz and 340 to 460 Hz.

3.5.2.2.1 Frequency Uncertainty. The RPMC AC voltage frequency uncertainty shall not exceed ± 0.1 Hz.

3.5.2.2.2 Resolution. The RPMC shall have the frequency resolution of 0.1% of reading or better.

3.5.3 DC Current Mode.

3.5.3.1 Range. The RPMC's DC current range shall be at least from 1 mA to 10 A. The DC Current shall be adjustable over the entire output range.

3.5.3.2 Amplitude Uncertainty. The RPMC DC current uncertainty shall not exceed $\pm(0.5\% \text{ i.v.} + 0.05\% \text{ rng})$ for current levels up to and including 5 mA, and $\pm(0.2\% \text{ i.v.} + 0.05\% \text{ rng})$ for current levels up to and including 5 mA, and $\pm(0.2\% \text{ i.v.} + 0.05\% \text{ rng})$ for higher ranges.

3.5.3.3 Resolution. The RPMC DC current resolution shall be 0.1% of the output current or better.

3.5.3.4 Compliance Voltage. The compliance voltage shall be at least:

6 Vdc for < 10 mAdc
12.5 Vdc for 10 mAdc to 50 mAdc
3 Vdc for > 50 mAdc

3.5.3.5 Level Stability. The RPMC output current level variations of less than 10 Hz shall be less than or equal to $\pm(0.03\% \text{ i.v.} + 0.015\% \text{ rng})$ over a 15 minute period.

3.5.4 AC Current Mode.

3.5.4.1 Current Range. The RPMC's AC current range shall be at least from 0.1 to 5 A rms in two ranges, 0.1 to 1 A rms and 1A to 5 A rms. The output shall be adjustable over the entire range.

3.5.4.2 Current Uncertainty. The RPMC's AC current uncertainty shall not exceed $\pm(0.2\% \text{ i.v.} + 0.05\% \text{ rng})$ rms for currents of less than 1 A rms, and not exceed $\pm(0.2\% \text{ i.v.} + 0.10\% \text{ rng})$ rms for to 1A rms or greater.

3.5.4.3 Resolution. The RPMC AC current resolution shall be 0.1 percent of setting or better.

3.5.4.4 Compliance Voltage. The compliance voltage shall be at least 6.0 Vrms on all ranges.

3.5.4.5 Level Stability. The RPMC output current level variations of less than 10 Hz shall be less than or equal to $\pm(0.03\% \text{ i.v.} + 0.015\% \text{ rng})$ rms over a 15 minute period.

3.5.4.6 Frequency. The RPMC AC current frequency capability shall conform to section 3.5.2.2.

3.5.5 Phase Angle Mode. The RPMC shall provide a variable phase angle mode for calibrating phase angle meters. The AC voltage and current output capabilities shall be as specified in section 3.5.2 with a voltage range of 15 to 750 Vrms. Current shall be as specified in section 3.5.4. Both sources shall be capable of operating simultaneously.

3.5.5.1 Phase Angle Range. The phase angle between the RPMS's voltage and current outputs shall be settable from -180 to +180 degrees.

3.5.5.2 Phase Uncertainty. The RPMC phase angle uncertainty shall not exceed ± 0.33 degrees.

3.5.5.3 Phase Resolution. The RPMC phase angle resolution shall be 0.1 degree or better.

3.5.5.4 Phase Stability. The RPMC phase angle variations shall not exceed 0.2 degrees, over a 1 minute period.

3.5.6 Power Factor Mode. The RPMC shall provide a power factor mode for calibrating power factor meters. The AC voltage shall be as specified in sections 3.5.2 with a voltage range of 15 to 750 Vrms. Current shall be as specified in section 3.5.4. Both sources shall be capable of operating simultaneously.

3.5.6.1 Range. The RPMC shall provide AC voltage and current outputs with a power factor ranging from 0.5 to 1 to -0.5. Power factor shall be adjustable over the entire output range.

3.5.6.2 Power Factor Uncertainty. The power factor uncertainty shall be less than or equal to ± 0.0005 pf.

3.5.6.3 Resolution. The RPMC power factor resolution shall be 0.003 or better over the entire range.

3.5.7 AC Power (Watts) Mode. The RPMC shall provide simultaneous voltage and current outputs for calibrating AC wattmeters. The AC voltage shall be as specified in section 3.5.2 with a voltage

range of 15 to 750 Vrms. Current shall be as specified in section 3.5.4. The phase angle shall be $0^\circ \pm 0.33^\circ$.

3.5.7.1 Range. The RPMC shall have the AC power output range at least from 1.5 VA to 3900 VA. AC power shall be adjustable over the entire output range. After the voltage is selected, the RPMC shall adjust the value of the current to develop the required power.

3.5.7.2 Amplitude Uncertainty. The RPMC AC power uncertainty requirement shall be derived from the algebraic sum of the absolute values of the AC voltage and AC current uncertainties.

3.5.7.3 Resolution. The RPMC AC power resolution shall be as follows or better:

0.01 VA for outputs of ≤ 10 VA
0.1% of setting for outputs of > 10 VA

3.5.7.4 Short Term Stability. The RPMC AC power output variations shall be less than or equal to the algebraic sum of the absolute values of the AC voltage level stability, AC current level stability and the phase angle stability.

3.5.8 Synchroscope Mode. The RPMC shall have an operating mode for calibrating synchrosopes, in which two AC voltage outputs of the same amplitude and frequency shall be provided by the RPMC.

3.5.8.1 Amplitude. The amplitude of the two outputs shall be 120 Vrms upon initial entry in synchroscope mode, and shall be settable above and below this nominal value over the range of 105 Vrms to 135 Vrms.

3.5.8.2 Frequency. The frequency shall be as specified in section 3.5.2.2.

3.5.8.3 Phase. The phase relationship between the two outputs in the synchroscope mode shall be selectable to either 0° or 180° , with a phase uncertainty of less than or equal to $\pm 0.33^\circ$.

3.5.8.4 Burden. In the synchroscope mode, the RPMC shall support a current burden of 130 mA rms on both outputs at 120 Vrms.

3.6 Functional Requirements. The RPMC shall provide the following functional and operating capabilities.

3.6.1 Modify Controls. The RPMC shall provide the operator with a means of increasing or decreasing output values, with at least three selectable rates of change. The minimum possible modification of output shall be one count resolution (equal to the resolution) at any output level and in any mode. The modify control shall consist of a combination of up-down buttons on the keyboard and on the Hand Held Unit (HHU), numerical entry of desired output value from the keyboard, and an analog type rotary

control on the RPMC front panel to modify the numerical setting. The rotary control knob shall be physically lockable.

3.6.2 Standby/Operate. STANDBY and OPERATE switches and indicators shall be provided on the front panel and HHU.

3.6.3 Status Display. The front panel displays shall indicate the actual status of the RPMC parameters in both remote and local modes.

3.7 TD/Noise. For all of the RPMC outputs, the total distortion and noise, ranging in frequency from 10 Hz to 10 kHz, shall be of an amplitude less than or equal to $\pm(1.0\% \text{ i.v.} + 0.5\% \text{ rng})$ rms or 1 mVrms, whichever is greater.

3.7.1 Settling Time. For all of the RPMC outputs, the settling time (the time required for a smooth excursion of the output to within 1% of the desired output) shall be between 1 and 4 seconds (inclusive) for a full-scale excursion. This applies when either changing output levels while already in OPERATE mode, or when switching between STANDBY and OPERATE modes.

3.7.2 Output Status Indicator. The RPMC shall have an output status indicator to provide a constantly or periodically (0.5 second or less) updated indication of whether the actual output has settled to the desired output.

3.7.4 Front Panel Control Requirements. All modes and functions shall be operable using front panel controls. The locations and labeling of indicators, controls and switches shall provide for maximum clarity and easily understood operation without reference to tables, charts, or flow diagram.

3.7.4.1 Display. The RPMC shall incorporate a high resolution vacuum fluorescent display on the panel to provide visual display of the bus address, output value, status, percent deviation, improper output messages, and operator prompting messages and instructions.

3.7.4.2 Keyboard. The RPMC shall have a keyboard style switch matrix to provide for operator input of all modes, functions, magnitudes and units.

3.7.4.3 Percent Deviation. The RPMC shall provide a percent deviation display mode to allow the operator to monitor the percent deviation of the output as it is varied about the nominal level, without incurring a degradation in accuracy. The percent deviation readout shall show the computer percentage excursion of the output, based upon the full scale value of the meter under test. The RPMC shall revert back to 0% deviation when the operator changes the RPMC mode or output setting within any mode.

3.7.4.4 High Voltage. Indicators shall be present to alert the operator of unsafe voltage conditions.

3.7.5 Hand Held Unit. The RPMC shall be remotely controllable via a Hand Held Unit (HHU). The HHU shall duplicate major instrument controls and indicators to permit the operator to safely modify the RPMC output while watching the meter being calibrated. As a minimum, the HHU shall provide the following functions: output value display, OPERATE, STANDBY, UP, DOWN, and memory STORE and RECALL.

3.7.6 Memory. The RPMC shall have a non-volatile memory, capable of storing at least 20 setting within a single mode. The memory device(s) shall not require electro-chemical elements (batteries) to maintain the stored data.

3.7.7 Cables. The RPMC shall be provided with two sets of cables for voltage, current, and the HHU. One set shall be a minimum 10 feet each in length, and the other set shall be a minimum of 20 feet each in length.

3.7.7.1 GPIB Cable. A IEEE-488 GPIB cable, 6 feet minimum length shall be supplied with each RPMC.

3.7.7.2 Connectors. The RPMC cable connectors for voltage, current, synchroscope and HHU shall resist disconnection from the RPMC when a force of 35 pounds is applied to the associated cable, while meeting the requirements of MIL-T-28800. At the UUT end of the voltage, current and synchroscope cables, banana type female connectors shall be provided. All connectors shall be of such quality and durability to withstand heavy use in the field. The chassis mounted connectors shall be clearly marked as to their function.

3.8 Operating Requirements. The RPMC shall provide the following capabilities.

3.8.1 Standby/Operate. A STANDBY/OPERATE switch shall be provided.

3.8.2 Output Protection. All outputs of the RPMC shall be fully protected from errors caused by improper connections. This includes shorting of the leads together or to ground, applying voltage to the leads (reverse voltage) and exceeding the current and burden limitations of the RPMC.

3.8.3 Error Correction. During calibration, the RPMC shall provide the capability to accept and store corrections for all measurement deviations from nominal conditions. The RPMC shall meet all the specified performance specifications without requiring additional entry of any calibration factor or other correction data.

3.8.4 Self Test. The self test shall determine operational readiness and isolate faulty modules.

3.8.4.1 Display. If the self test fails, the display shall indicate the nature of the failure and provide directions for diagnostic action.

3.9 Digital Interface. The RPMC shall provide a digital interface as specified in MIL-T-28800 and IEEE-STD-488-1978 or IEEE-STD-488.1-1987 with the exceptions noted below.

3.9 Remote Programming Requirements. All modes, functions, and inputs/outputs of the RPMC shall be remotely programmable over the IEEE-488 General Purpose Interface Bus (GPIB).

3.9.2 GPIB Capabilities. The following IEEE-488 capabilities shall be provided:

T6 or TE6 - Talker
L4 or LE4 - Listener
SR1 - Service request

3.9.3 Status Register Access Requirements. Access to the status register shall be available via the IEEE-488 bus to ascertain RPMC mode, range and other operational and error status.

3.9.4 Bus String Terminator Requirements. Terminators for a string of bus commands shall be a carriage return followed by line feed and EOI signal.

3.9.5 Bus Address Switch. Address must be selectable without removing any covers.

3.9.6 Bus Error Handling Requirements. Bus error reporting and recovery conventions shall be fully described in the Operational and Maintenance Manual.

3.9.7 Compatibility. The RPMC, when used as part of an automated system, shall be capable of automatically energizing and/or calibrating applicable test instruments and measurement systems that are IEEE-488 bus configured. The RPMC shall be compatible with the FLUKE 1722A and 1722A/AP Instrument Controllers.

3.10 Manual. At least two copies of an operation and maintenance manual shall be provided. The manual shall meet the requirements of MIL-M-7298.

3.10.1 Calibration Procedure. The manual shall provide a RPMC calibration procedure in accordance with MIL-M-38793.

